



## QUALITY OF ROSELLE TEA AS AFFECTED BY DRYING TEMPERATURES AND STORAGE TIME

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### ABSTRACT

The quality of roselle tea (*Hibiscus sabdariffa* L.) extracted from two locally grown varieties was investigated. Roselle calyxes were dried immediately after harvesting (AH) or frozen (AF) for two weeks prior to drying using a food dehydrator at 40, 50 and 60°C overnight. Roselle tea were packed in sachet and stored at room temperature for 12 months. Quality of tea measured were antioxidant activities by 2, 2-diphenyl-1-picrylhydrazyl (DPPH), total phenolics by Folin-Ciocalteu method and total anthocyanins by the pH-differential method. Color measurements were measured by UV-VIS spectrophotometer. DPPH and pH of tea was not affected by drying conditions and storage. Total phenolic content was affected by drying temperatures, variety and condition of calyxes before drying. Drying at 60°C caused significant reduction ( $p < 0.001$ ) in anthocyanin content for both roselle teas. Significant losses in colour and anthocyanin content were observed in dried roselle calyxes during storage.

*Keywords:* Roselle tea; Anthocyanin content; DPPH; Phenolic content; Tea quality

### INTRODUCTION

Roselle calyxes have been found to be rich in vitamin C and other antioxidants such as flavonoids and also minerals (Babalola & Aworh, 2001). The abundant pigments in roselle are responsible for the red colour

and are the main source of its antioxidant capacity (Tsai et al., 2002). However, the pigment is quite unstable during both processing and storage. Roselle calyxes contain two main anthocyanins: delphinidin-3-sambubioside or delphinidin-3-xylosylglucoside or hibiscin and cyanidin-3-sambubioside or cyanidin-3-xylosylglucoside or gossypicyanin, and two minor anthocyanins, delphinidin-3-glucoside and cyanidin-3-glucoside (Du & Francis, 1973).

Light, pH, temperature, oxygen, ascorbic acid and sugar are considered to be important factors in influencing anthocyanin degradation or stability. During heating, degradation and polymerization usually leads to anthocyanin discoloration (Markakis, 1982). Addition of table sugar, increasing storage temperature, use of food acidulants and packaging material also contribute to anthocyanin degradation in roselle beverages (Aina & Shodipe, 2006; Zaiton et al., 2008). Sun-drying of roselle calyxes is the normal practices of producing the tea. The interest in roselle tea as a healthy drink is becoming popular in Malaysia. This study reports the changes in quality of tea produced by drying roselle calyxes at different temperatures and storage time.

## MATERIALS AND METHODS

Roselle calyxes from two locally grown varieties (Arab and Rengit) were used as raw material. The calyxes were cleaned to remove dirt particles and washed with tap water before drying immediately after harvesting (AH) or frozen (AF) for two weeks prior to drying using a food dehydrator at 40, 50 and 60°C overnight. Dried roselle calyxes were ground, packed in sachet and stored at room temperature for 12 months. Roselle tea was prepared by steeping it in hot water for about five minutes (0.5g roselle tea in 250ml hot water). The pH values of the roselle tea were determined by a combined glass electrode and a pH meter (827, pH Lab Metrohm). All colour measurements were measured using UV-VIS spectrophotometer model UV-VARIAN 50.

The monomeric anthocyanin content of roselle tea was measured using a spectrophotometric pH differential protocol (Boyles & Wroldstat, 1993). The absorbance of the mixture was measured at 515nm and 700nm. The anthocyanin content was expressed in terms of relative anthocyanins content (mg/ml). Color measurements (A520, hue, chroma, browning index and degradation index of anthocyanin) of the tea samples were measured using UV-VIS spectrophotometer. The measurements were red color at A520nm; hue as  $\tan^{-1}$  (L/a); colour intensity at A420nm + 520nm; browning index measured at A420nm, and degradation index of anthocyanin as A420nm/520nm. The colour quality of tea was evaluated by colour density (A420 + A520 + A620) and colour tonality (A420/A530) (Rommel et al., 1990). Total phenolic contents of roselle tea were determined using a modified Folin-Ciocalteu method (Wolfe et al., 2003) using gallic acid as the standard, and absorbance measured at 760 nm, expressed as gallic acid equivalents in mg/g (dw). DPPH (2, 2-diphenyl-

1-picrylhydrazyl) radical scavenging activity was determined following the method of Brand-Williams et al. (1994) using Trolox as standard. The antioxidant activity was reported in  $\mu$ moles of Trolox equivalents per gram sample ( $\mu$ mol TE/ g dw). All analyses were done in duplicate and were analyzed using ANOVA with significant differences between mean at ( $p < 0.001$ ) determined by Generalised Linear Model (GLM) and Duncan's multiple range tests (DMRT) using SAS 9.0V.

## RESULTS AND DISCUSSION

The pH values of different varieties of roselle tea dried at different temperatures ( $40^{\circ}\text{C}$ ,  $50^{\circ}\text{C}$  and  $60^{\circ}\text{C}$ ) did not change significantly ( $p < 0.001$ ) during the 12 months storage. pH for roselle tea were around 2.56-2.6 before storage but increased to 2.75-2.81 during 12 months storage.

The total anthocyanin content of tea prepared from AH calyxes was generally higher in roselle Arab than roselle Rengit. Greater loss of anthocyanin in tea (40 to 60%,  $p < 0.001$ ) was observed from both varieties of AF than AH roselle calyxes during the 12 month storage. The anthocyanin content of AH tea, dried at  $50^{\circ}\text{C}$  after 12mth storage was 156.3mg/ml and 118.91mg/ml for roselle Arab and Rengit, respectively. The anthocyanin content of the roselle tea was higher than that reported by Chumsri et al. (2008) which may be contributed to varietal differences. Anthocyanin content of roselle tea is affected by storage time; longer storage resulted in greater reduction in anthocyanin content. Loss of anthocyanin was observed during storage of roselle beverages (Zaiton et al., 2008, Aina & Shodipe, 2006), and storage of freeze-dried roselle extract (Duangmal et al. 2007).

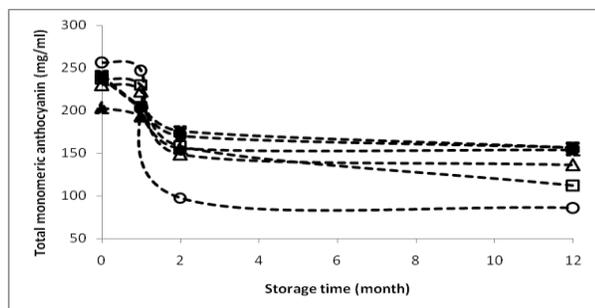


Figure 1: Total monomeric anthocyanin in AH and AF roselle Arab dried at different drying temperature  $^{\circ}\text{C}$ : (▲) AH40, (■) AH50, (●) AH60, (△) AF40, (□) AF50, (○) AF60.

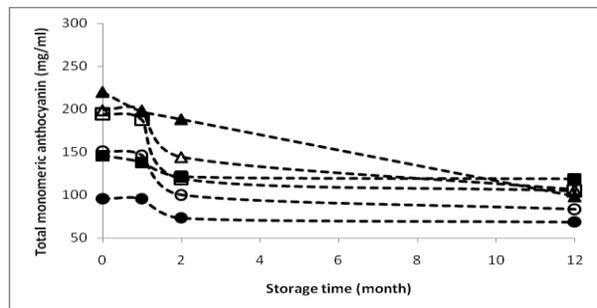


Figure 2: Total monomeric anthocyanin in AH and AF roselle Rengit dried at different drying temperature  $^{\circ}\text{C}$ : (▲) AH40, (■) AH50, (●) AH60, (△) AF40, (□) AF50, (○) AF60.

A plot of  $\ln(C/C_0)$  versus storage time (where  $C$  is anthocyanin content after  $t$  days of storage and  $C_0$  is initial anthocyanins content) yields a straight line (Fig. 3 & 4). Degradation of anthocyanins followed first-

order reaction kinetic as reported by others (Duangmal et al. 2007, and Zaiton et al., 2008). The reaction constant of anthocyanin in tea from AH Arab dried at 40 and 50°C were  $k = 1.67 \times 10^{-2} \text{ month}^{-1}$  and  $k = 2.79 \times 10^{-2} \text{ month}^{-1}$ , respectively. Degradation of anthocyanin was higher for both AH and AF Rengit dried at 40°C with  $k = 3.14 \times 10^{-2} \text{ month}^{-1}$  and  $k = 4.15 \times 10^{-2} \text{ month}^{-1}$ , respectively. Drying at 60°C resulted in higher degradation index of anthocyanin for tea from both roselle varieties. Higher loss of anthocyanin was observed in tea from AH roselle Rengit ( $k = 6.03 \times 10^{-2} \text{ month}^{-1}$ ) compared to AH Arab ( $k = 3.23 \times 10^{-2} \text{ month}^{-1}$ ) dried at 60°C. Oxygen and heat have been reported as the most important factors affecting the destruction of anthocyanins (Jackman & Smith, 1992). Oxygen may cause oxidative degradation of anthocyanins directly or indirectly, via oxidized constituents, to yield colourless or brown-coloured pigments. The drying temperatures used and low water activity of tea (ca  $a_w$  0.5) resulted in higher degradation index of anthocyanin for roselle calyxes compared to reports by others in roselle juice or beverage (Duangmal et al., 2007). Under the processing and storage conditions used in this study anthocyanin pigments in the dried calyxes were degraded even though the pH was around pH 2.5.

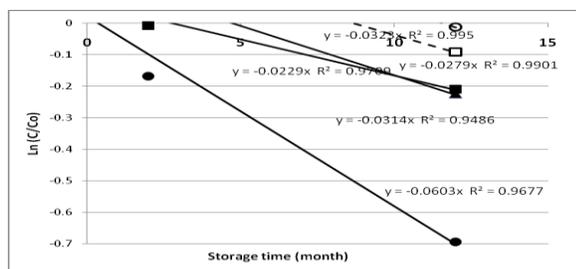


Figure 3: Degradation index of anthocyanin in AH roselle Arab and Rengit dried at different drying temperature °C: (Δ) AH40-A, (□) AH50-A, (○) AH60-A, (▲) AH40-R, (■) AH50-R, (●) AH60-R.

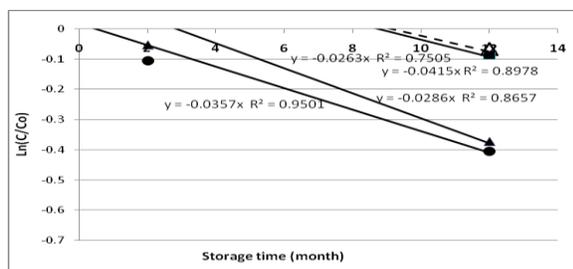


Figure 4: Degradation index of anthocyanin in AF roselle Arab and Rengit dried at different drying temperature °C: (Δ) AF40-A, (□) AF 50-A, (○) AF 60-A (▲) AF 40-R, (■) AF 50-R, (●) AF 60-R.

Colour analysis of tea revealed that increasing storage time resulted in changes in lightness, chroma and hue of tea dried at different temperatures. Significant increase in lightness and decrease in chroma and hue were observed in roselle Rengit, particularly when the calyxes were dried immediately after harvest at 60°C (Fig. 5 to 10). The differences in lightness, chroma and hue in tea from roselle Rengit is larger than those in tea from roselle Arab. Loss of redness was observed greater in tea from roselle Rengit than roselle Arab. Changes in redness strongly correlated to changes in amount of anthocyanins, and therefore considered as good indicator of anthocyanin content (Duangmal et al, 2007). This result agrees with the differences in changes of anthocyanin content between the two roselle varieties.

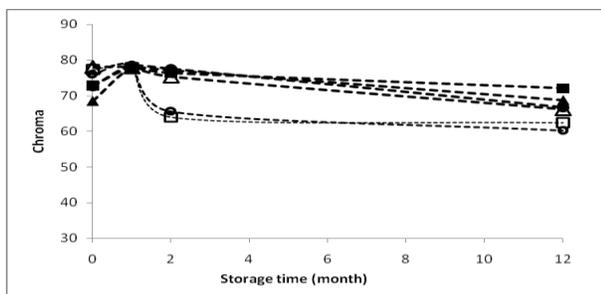


Figure 5: Changes in Chroma of AH and AF roselle Arab dried at different drying temperature °C: (▲) AH40, (■) AH50, (●) AH60, (Δ) AF40, (□) AF50, (○) AF60.

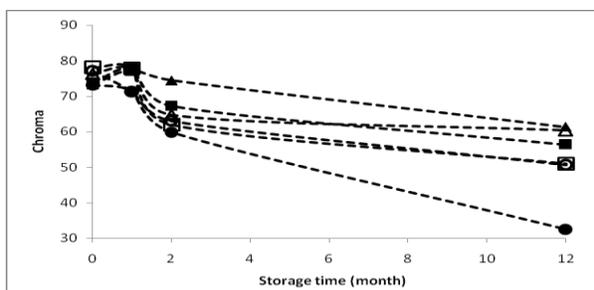


Figure 6: Changes in chroma of AH and AF roselle Rengit dried at different drying temperature °C: (▲) AH40, (■) AH50, (●) AH60, (Δ) AF40, (□) AF50, (○) AF60.

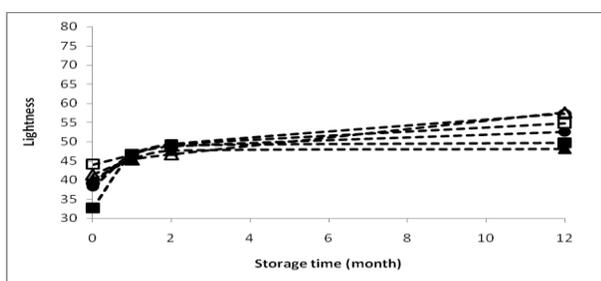


Figure 7: Changes in lightness of AH and AF roselle Arab dried at different drying temperature °C: (▲) AH40, (■) AH50, (●) AH60, (Δ) AF40, (□) AF50, (○) AF60.

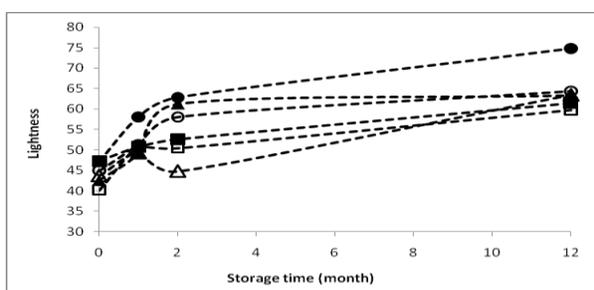


Figure 8: Changes in lightness of AH and AF roselle Rengit dried at different drying temperature °C: (▲) AH40, (■) AH50, (●) AH60, (Δ) AF40, (□) AF50, (○) AF60.

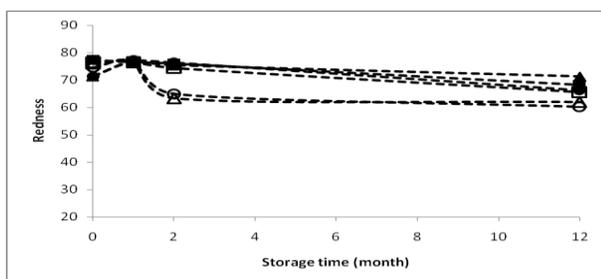


Figure 9: Changes in redness value of AH and AF roselle Arab dried at different drying temperature °C: (▲) AH40, (■) AH50, (●) AH60, (Δ) AF40, (□) AF50, (○) AF60.

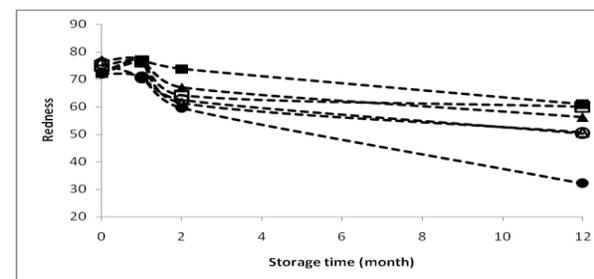


Figure 10: Changes in redness value of AH and AF roselle Rengit dried at different drying temperature °C: (▲) AH40, (■) AH50, (●) AH60, (Δ) AF40, (□) AF50, (○) AF60.

The free scavenging activity (DDPH) in tea was not affected by drying temperatures and storage with values of 53 $\mu$ mol TE/g. for all samples. It was observed that despite colour changes and breakdown of anthocyanins still, tea stored for 12 months exhibited significant antioxidant activity. Similar result was reported by Grandinaru et al. (2003). The total polyphenol content (TPC) of the roselle teas were determined using Folin-Ciocalteu phenol reagent. From Fig. 11 &12, the TPC generally decreased during storage.

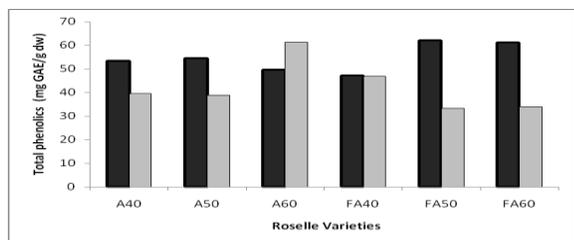


Figure 11: Total phenolic contents in AH and AF roselle dried at different drying temperature during 12 month storage: (■) 0 month, (■) 12 month.

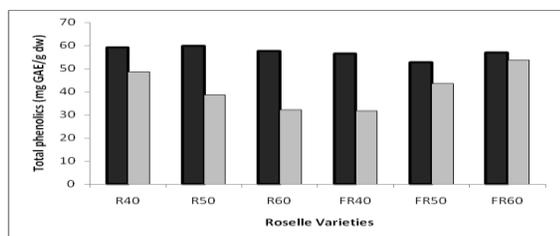


Figure 12: Total phenolic contents in AH and AF roselle dried at different drying temperature during 12 month storage: (■) 0 month, (■) 12 month.

However, exceptions were observed in tea from AH roselle Arab and AF roselle Rengit dried at 60°C exhibited lower antioxidant activity. The determination of total phenol by Folin-Ciocalteu phenol reagents assay has been shown not specific to polyphenols, but to any substance that could be oxidized by the Folin reagent (Wong et al., 2006). Some monomeric anthocyanins may be converted into polymerized phenolics during storage as suggested by Tsai et al. (2002).

## CONCLUSIONS

Anthocyanin content and the colour quality of tea (redness, lightness, chroma, and hue) are affected by drying temperatures, storage time and roselle variety. Roselle tea provides a good source of antioxidant during storage, despite loss of anthocyanin, colour intensity and total phenolic content.

## ACKNOWLEDGMENTS

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## REFERENCES

- Aina, J.O. and Shodipe, A.A. 2006. Colour stability and vitamin C retention of roselle juice (*Hibiscus sabdariffa L.*) in different packaging materials. *Nutri. Food Sci.* 36, 90-95.
- Babalola, S.O., Babalola V, A.O. and Aworh, O.C. 2001. Compositional attributes of roselle (*Hibiscus sabdariffa L.*). *J. Food. Technol. Africa.* 6, 133-134.
- Boyles, M. and Wroldstad, R.E. 1993. Anthocyanin composition of red raspberry juice: influences of cultivar, processing and environmental factors. *J. Food. Sci.* 58 (5), 1135-1141.
- Brand-William, W., Cuvelier, M.E. & Berset, C. 1995. Use of a free radical method to evaluate antioxidant activity. *Lebensmittel-Wissenschaft und Technologie*, 28, 25-30.
- Chumsri, P., Sirichote, A. and Itharat A. 2008. Studies on the optimum conditions for the extraction and

- concentration of roselle (*Hibiscus sabdariffa* Linn.) extract. *Songklanajarin J. Sci. Technol.* 30,133-139.
- Du, C. T. and Francis, F. J. 1973. Anthocyanins of roselle extract (*Hibiscus sabdariffa* L.). *J. Food. Sci.* 38, 810–812.
- Duangmal, K., Busararat, S. and Suchitra, S. 2007. Colour evaluation of freeze-dried roselle extract as a natural food colorant in a model system of a drink. *J. Food. Sci and Technol.*
- Gradinaru, G., Biliaderis, C.G., Kallitharaka, S., Kefalas, P. and Garcia-Viguera, C. 2003. Thermal stability of *Hibiscus sabdariffa* L. anthocyanins in solution and in solid state: effects of copigmentation and glass transition. *J. Food. Chem.* 83,423-436.
- Markakis, P. 1982. Stability of anthocyanins in foods. In P. Markakis (Ed.) *Anthocyanins as Food Colours* 163-180. Academic Press: New York.
- Rommel, A., Heatherbell, D.A. and Wroldstat, R.E. 1990. Red raspberry juice and wine: Effect of processing and storage on anthocyanin pigment composition, colour and appearance. *J. Food. Sci.*55, 1011-1017.
- Tsai, P.J., McIntosh, J., Pearce, P., Camden, B. & Jordan, B.R. 2002. Anthocyanin and antioxidant capacity in roselle (*Hibiscus sabdariffa* L.) extract. *Food Research Int.*, 35, 351-356.
- Wolfe, K., Wu, X. and Liu, R. H. 2003. Antioxidant Activity of Apple Peels. *J. Agri. Food. Chem.* 51, 609–614.
- Wong, S.P., Leong, L.P. and Koh, J.H.W. 2005. Antioxidant activities of aqueous extracts of selected plants. *J.Food. Chem.* 99,775-783.
- Zaiton, H., Ahmed-Mahir, M.M.B., Salmah, Y., Che Wan Zanariah, C.W.N., Chek Zaini, H., Suzila, I., Siti-Sarah, M.D. & S. Herman. 2008. Effect of tea extract on color of roselle beverages. *Proceedings: Perspective, Challenges and Opportunities in Food Biotechnology*, 25-26 November, Hotel Equatorial, Bangi.